ARMY RESEARCH LABORATORY

Human Factors Evaluation of the g-MAV Micro-Air Vehicle

by Rodger A. Pettitt and Jeffrey Williams

ARL-TR-4169 **July 2007**

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14. ABSTRACT

This study was conducted by the U.S. Army Research Laboratory's Human Research and Engineering Directorate in support of the Soldier Battle Lab's (SBL) micro-air vehicle (MAV) Advanced Concept and Technology Demonstration (ACTD). The MAV ACTD was a 4-year program consisting of requirements definition, technology development, integration, demonstrations, and assessments. The primary purpose of the study was to conduct a comprehensive human factors evaluation of the gas-powered version MAV (g-MAV) system. The study was conducted in conjunction with the SBL's military utility assessment (MUA) of the system. Force-on-force operational missions were conducted in order to assess the military utility of the g-MAV system. The operational missions consisted of reconnoitering a built-up area and searching a building, conducting a route reconnaissance, and conducting an area reconnaissance. All missions were executed during the hours of daylight. The human factors engineering evaluation of the g-MAV system was accomplished during the MUA through the use of structured questionnaires, expert observations, Soldier interviews, and after-action reviews. Results demonstrate that when operating properly, the g-MAV system enhanced situational awareness by enabling Soldiers to identify and confirm enemy positions, personnel, and vehicles without exposing themselves to risk. The results also indicated several areas requiring improvement, including system reliability, durability, and operator proficiency. Specific procedures that were problematic for the Soldiers were engine tuning, reconfiguration of radios, pre-flight checks, and avionics pod interchange procedures. Recommendations were made to improve training by expanding the duration of the operator training course and restructuring the training to focus more time on areas where Soldiers demonstrated performance deficiencies.

15. SUBJECT TERMS
ground data terminal (GDT), micro air vehicle (MAV), military utility assessment (MUA), operator control unit (OCU), unmanned aerial vehicle (UAV)

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1. Introduction

1.1 Background

The micro-air vehicle (MAV) Advanced Concept and Technology Demonstration was a 4-year program consisting of requirements definition, technology development, integration, demonstrations, and assessments. Its primary objective was to demonstrate a reconnaissance and surveillance unmanned aerial vehicle (UAV) with a back-packable ducted fan, vertical take-off and landing, which is affordable, easy to operate, and responsive. The gasoline-powered MAV (g-MAV) military utility assessment (MUA) followed the g-MAV functionality assessment event.

The MAV system transitioned from the transitional MAV (t-MAV) to a g-MAV variation after major re-design and system modifications increased the air vehicle's (AV) endurance, enhanced sensor imagery, and increased target detection probability.

Operator training for the key leaders of the designated assessment platoon was conducted 28 August through 1 September 2006, at Albuquerque and Laguna, New Mexico, by Honeywell personnel. The assessment team deployed to Schofield Barracks, Hawaii, on 13 September to prepare for the platoon operator training course and the ensuing MUA. Operator training and the MUA were conducted at Schofield Barracks from 25 September through 27 October 2006.

1.2 Purpose of Assessment

The purpose of the g-MAV MUA was to determine the military utility and operational readiness of the g-MAV system for small-unit employment. The MUA consisted of a cavalry platoon executing four offensive cavalry platoon and squad collective tasks while facing a tactically relevant opposing force.

2. Procedures and Methodology

2.1 Overview

ARL personnel conducted a human factors engineering evaluation (HFEE) of the g-MAV system during the assessment. This was accomplished through the use of structured questionnaires, expert observations, Soldier interviews, and after-action reviews (AARs).

Force-on-force operational missions were conducted in order to assess the military utility of the g-MAV system. The operational missions consisted of reconnoitering a built-up area, searching a building, conducting a route reconnaissance, and conducting an area reconnaissance. All missions

were executed during daylight hours. Reconnoitering a built-up area and searching a building were conducted at night. Each mission required the operator to plan g-MAV flight missions and tactically employ the g-MAV in support of the platoon's reconnaissance effort for that particular mission, based on the platoon leader's guidance.

HFEE questionnaires were administered to capture data pertaining to demographics and training, plus various aspects of human-machine interface for mission performance. Activities addressed in the questionnaires included emplacement/displacement, engine tuning, operator control unit (OCU) display, tactical operational tasks and checks, flight planning, manual/autonomous/semi-autonomous flight, and target detection. At the completion of each operational mission, an AAR questionnaire was administered to the leaders. At the completion of the assessment, ARL personnel administered an end-of-test questionnaire to the g-MAV operators and unit leaders. All questionnaires were designed to allow Soldiers to rate tasks and characteristics on a 7-point scale, with 1 being extremely bad (difficult) and 7 being extremely good (easy). They used similar scales to rate the ease of operation and provided their overall rating for the g-MAV system used for a particular event.

2.2 Participants

Test Soldiers consisted of a 15-man mounted Scout Platoon from A Troop, 5-14th Cavalry, 2nd Stryker Brigade Combat Team, 25th Infantry Division with four designated g-MAV operators.

2.3 System Description

The g-MAV system consists of two AVs, a ground station (GS) consisting of a ground data terminal (GDT) and an OCU, payload (one electro-optical and one infrared [IR] pod) and an avionics pod for both AVs, and support equipment. The g-MAV is a "proof-of-concept" system capable of supporting a dual video camera system consisting of one forward looking and one downward looking camera. Half of the AVs were equipped with IR cameras and the remaining half with electro-optical (EO) cameras (sensor payloads). However, any AV can use either the IR or EO payload pods since they are interchangeable.

The GS includes telemetry interfaces used to control and monitor the AV. Telemetry includes near real-time video sourced from the payload pods and displayed for the operator on the OCU. Operators used the GS to conduct mission planning and to maintain control of the AV during flight. The OCU is the operator's display and data entry device, and the GDT contains the up-link and down-link communications radios, a global positioning system (GPS) receiver, temperature sensor, battery, and power conditioning circuitry. A vibratory alert is also included in the GS package. The support equipment for the system includes a fuel syringe, fuel containers, engine starter assemblies, batteries, an operator tool kit, and an engine-tuning tool.

The modular backpack transport container system holds all components of the g-MAV system during transport and storage. Two backpack containers can be used to transport one g-MAV

system. During the MUA, Soldiers transported the system using Stryker vehicles with minimal use of the backpack configuration. Figures 1 through 6 depict component parts of the g-MAV system.

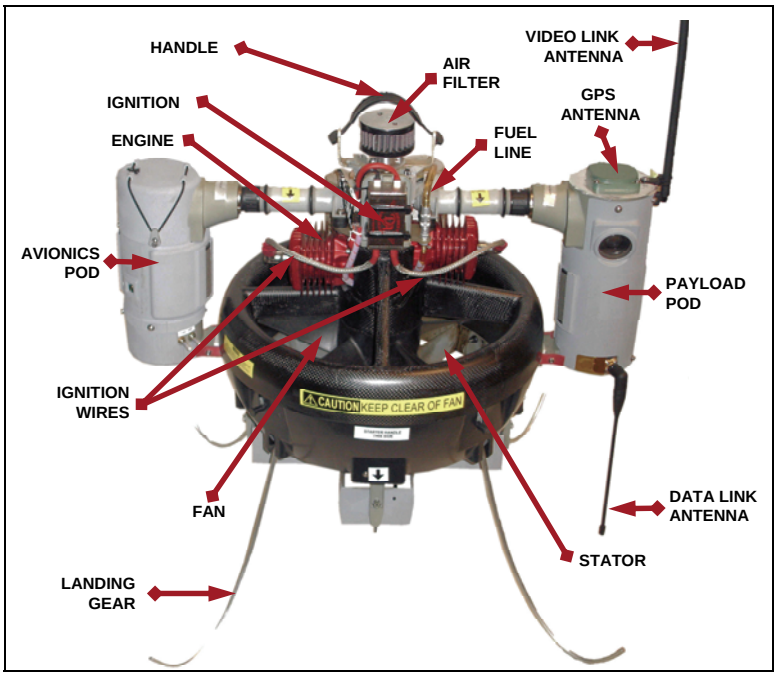

Figure 1. Front view of the AV.

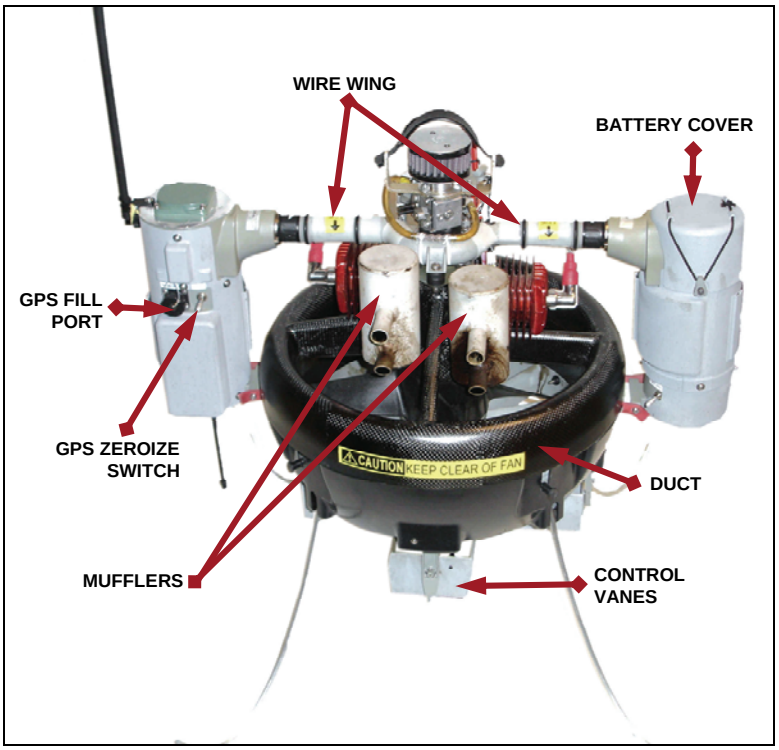

Figure 2. Rear view of the AV.

Figure 3. GS (OCU and GDT) components.

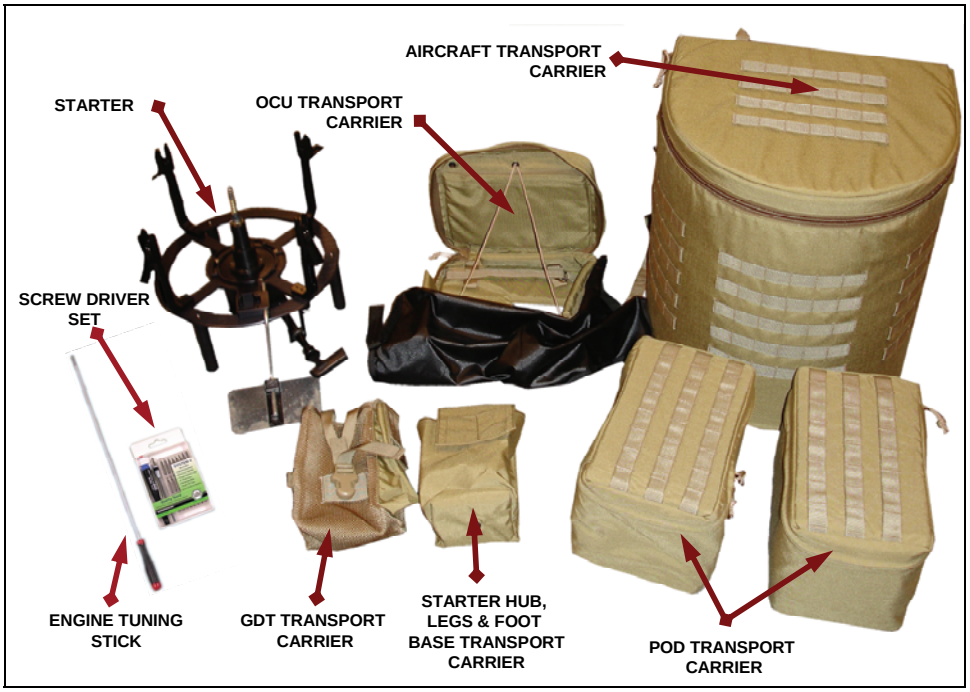

Figure 4. Support equipment components.

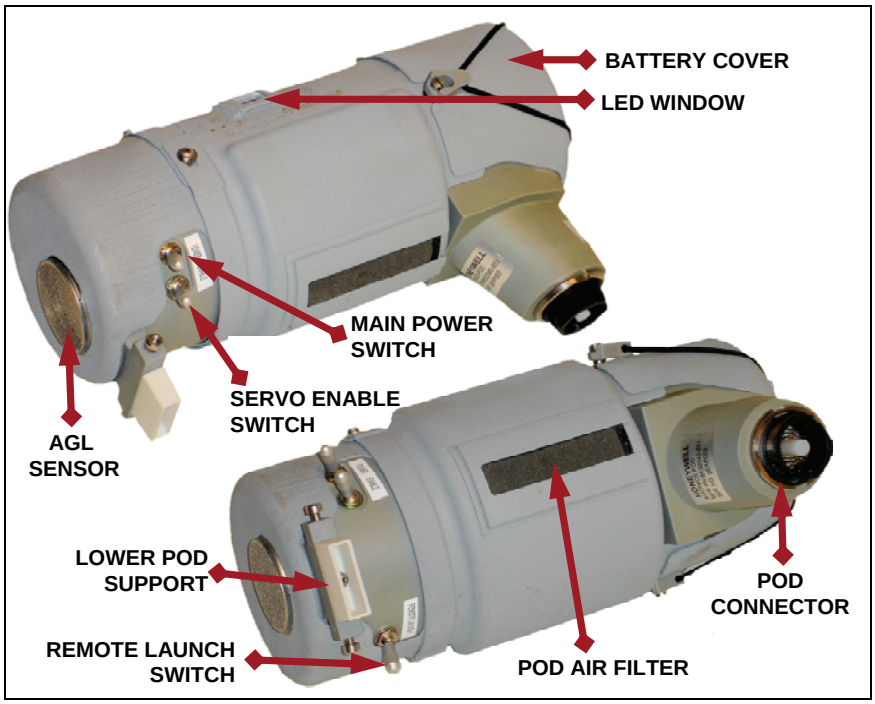

Figure 5. Avionics pod component.

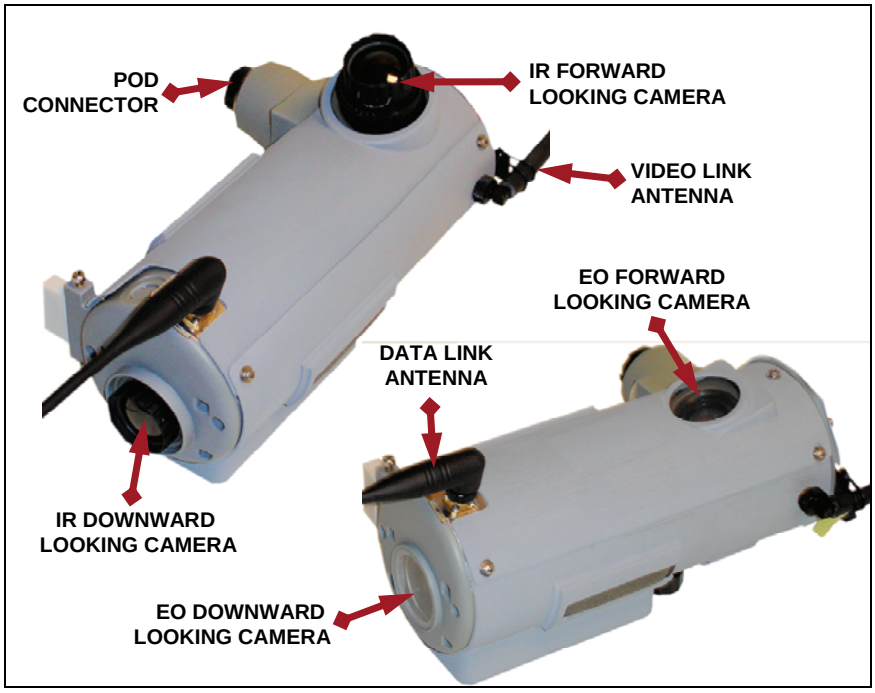

Figure 6. Sensor payload (IR and EO camera).

2.4 Methodology

2.4.1 Demographics

Before any events were conducted, all test Soldiers were administered a demographics questionnaire designed to elicit military history and service data, previous computer experience, and general physical characteristics data.

2.4.2 Training

Training was conducted over a 5-day period of instruction, which consisted of classroom lectures and hands-on field training. Before being certified by Honeywell personnel, Soldiers were required to demonstrate their ability to emplace/displace the system, perform engine tuning, plan flights, fuel and de-fuel the AV, and control the AV in the manual, autonomous, and semi-autonomous flight modes. Training was conducted by Honeywell personnel for the operators and their leaders. Leader training was conducted in Albuquerque before the assessment and was designed so that the leaders could provide supervision for the operators during the force-on-force operational missions. Operator training was conducted during the assessment at Schofield Barracks. At the completion of their training, Soldiers were administered a questionnaire designed to elicit feedback about course content, ratio of hands-on training to lectures, and self-evaluation data.

2.4.3 Tasks

2.4.3.1 Emplacement/Displacement

Soldiers performed emplacement/displacement tasks in accordance with the technical manual for the system. These tasks primarily included unpacking and assembling the system, conducting a pre-flight inspection, performing a servo-enabling test, and disassembling and packing the system for transportation. Operators were timed during emplacement and displacement trials. The emplacement time stopped when the Soldier had completed the assembly and the OCU indicated the AV was ready to start. Displacement time ended when all components were properly disassembled and stowed in the carrying cases.

2.4.3.2 Engine Tuning

As a function of maintenance and sustainability, Soldiers performed engine tuning during day and night in accordance with the technical manual. This task primarily included placing the AV into a maintenance state, starting the engine, and adjusting the high and low end carburetor needle valves by ear to obtain optimum engine performance.

2.4.3.3 Manual/Autonomous/Semi-Autonomous Flight

Soldiers flew the g-MAV in the manual, autonomous, and semi-autonomous modes during training and operational missions. During manual flights, Soldiers were required to enter all directional commands including the launch and landing commands. During autonomous missions, Soldiers

uploaded a pre-programmed flight plan that allowed them to launch and recover the AV without entering directional commands. The semi-autonomous flights were conducted when an operator suspended a flight plan and entered manual commands during a flight.

2.4.3.4 Flight Planning

Based on the platoon leader's mission guidance, Soldiers were required to program a flight plan using the OCU in accordance with the technical manual. For each operational mission, the flight plan consisted of waypoints with varying altitudes and actions at each. Soldiers were required to apply flight-planning rules to ensure a viable flight plan.

2.4.3.5 Target Detection

During each operational mission, human targets, vehicles, and training devices representing improvised explosive devices (IEDs) and a mortar were placed at locations within the platoon's area of operation. The Soldiers were required to find the target using the forward or downward looking camera and to determine if the target was civilian or military. Target detection missions were flown during the daytime missions with the EO camera payload or the IR camera payload and at night with only the IR camera payload.

2.4.3.6 Tactical Operational Tasks and Checks

Before, during, and after each operational mission, operators were required to perform a variety of tasks. Upon completion of each operational mission, Soldiers were administered a questionnaire designed to capture data relating to employment of the g-MAV during tactical situations.

3. Results

3.1 Demographics

Four enlisted personnel with the ranks of E-3 and E-4 served as g-MAV operators. The Scout platoon was additionally manned by ten enlisted personnel with the ranks of E-2 through E-7 and one O-1 platoon leader. All test Soldiers had a Scout MOS of 19D. The g-MAV operators' average time in service was 18 months. Since the system has a computer interface, the operators were asked to report their extent of familiarity and ability with computer use and typing. One rated himself as novice, one as advanced, and two as intermediate regarding computer experience. All four Soldiers indicated that they use a computer daily. Three of the operators had prior experience with digital or electronic military displays. None of the operators had prior experience in operating UAVs. Detailed demographic results are included in appendix A.

3.2 Training

Although Soldiers rated their training highly, individual confidence was low during execution of the experiment. The operator certification process did not include hands-on testing which would have required the operator to show proficiency in tasks without the assistance from an instructor. Soldiers were considered certified after they performed a task, regardless of whether they were assisted. Throughout the duration of the assessment, Soldiers required close supervision and often had to be "talked through" sequences and procedures. During each operational mission, Honeywell personnel had to assist the operator with configuring communications and payload pods in order to launch the AV. During mission AARs, leaders and operators commented that training should be longer than the 5 days provided, and more time should be spent on tactical employment. Detailed training results are included in Soldier questionnaire results (see appendix B).

3.3 Emplacement/Displacement

Soldiers were timed during emplacement and displacement trials. The average emplacement time was 6 minutes 49 seconds, and the average displacement time was 4 minutes 29 seconds. Questionnaire results indicated that the Soldiers were able to perform the tasks with relative ease. However, in one instance, a Soldier forgot to attach the landing gear to the AV, and in another, a Soldier forgot to attach the GDT to the OCU and was unable to complete the emplacement tasks without assistance. Several Soldiers commented that the storage bag for the starter hub was too small, and they had difficulty packing the starter, starter stand legs, and foot brace. Detailed emplacement/ displacement results are included in Soldier questionnaire results (see appendix B).

3.4 Engine Tuning

Soldiers rated daytime engine-tuning tasks between easy and extremely easy. Based on Soldier comments and data collector observations, the most difficult task for engine tuning was adjusting the needle valve screws. Access to the adjustment screws was partially obscured by fuel lines. Initial valve settings require the Soldier to turn the screws a set distance; however, there is no reference mark on the screw or tool to determine the amount of rotation. Performing engine-tuning tasks at night was more difficult because there are no reference marks on the engine-tuning tool and no audio, visual, or tactile feedback when the default settings are obtained. Adding audio, visual, or tactile feedback to the adjustment screws would aid Soldiers when they are adjusting the screws to their initial settings. Detailed engine-tuning results are included in Soldier questionnaire results (appendix B).

3.5 Flight Planning

Operators were required to design flight plans that supported autonomous flights during training and in support of the operational missions. All the autonomous flight plans were successfully executed. However, problems were encountered when there were substantial variations in terrain elevation between waypoints. In several mission sequences, Honeywell personnel stated that the

AV would have crashed into a hill, based on the autonomous flight plan operators entered into the system. In those cases, the flight plan had to be suspended and the AV flown manually. Soldiers indicated they needed more training in order to design flight plans that take into account variations in terrain elevation. Detailed flight planning results are included in Soldier questionnaire results (appendix B).

3.6 Target Detection/Display

Soldiers were able to detect and identify targets in daytime and nighttime conditions using the EO and IR cameras. However, Soldiers had difficulty in obtaining a stable image when flying the AV in windy conditions. For windy conditions, Soldiers rated the stability of image during target detection between ineffective and very ineffective. Soldiers also experienced problems with out-of-focus video images, static and flickering camera images on the OCU, and poor video image because of water on the camera lens during missions flown in the rain. Most Soldiers commented on the difficulty they had maneuvering the AV to the target area and obtaining a stable image in windy conditions (10 to 25 knots). A camera stabilization system may alleviate problems encountered during windy conditions, and a pan-and-tilt control would allow the Soldier more flexibility in maneuvering the AV to a position to view the target area.

Soldiers rated display tasks in daytime and nighttime conditions between easy and extremely easy. Soldiers had difficulty on several occasions using the stylus with the touch screen. Even after calibrating the stylus pen, Soldiers had to tap the OCU screen several times before commands were accepted. Soldiers also commented that viewing the screen in direct sunlight was difficult unless they shaded the screen. Detailed target detection/display results are included in Soldier questionnaire results (appendix B).

3.7 Tactical Operational Tasks and Checks

Engine tuning and establishing a communications link with the AV were two primary problems that Soldiers encountered when using the g-MAV during operational missions. Operators tuned the AV engines during pre-combat inspections, but on several occasions, the engines had to be re-tuned before the flight for the mission, which caused delays in launching the AV. The requirement to re-tune was attributed by Honeywell engineers to slight changes in temperature between the time of the pre-combat inspections and the time when the mission began.

On several occasions, the GDT failed to make video link with the AV before launching. Failure to establish a video link was attributed by Honeywell engineers to improper establishment of a communication link between the payload pod and the avionics pod or because of a faulty GDT. Honeywell engineers had to assist Soldiers in troubleshooting communication and/or video link failures during every operational mission. On two occasions, the AV failed to establish video link because the video up-link antenna connector was broken during AV assembly. The antenna connector has to be loosened before the antenna swings into the up position or the connector will

over-tighten and break. After the problem of over-tightening was identified, Soldiers were directed to completely remove and install the antenna, rather than rotating it into place while it was attached.

Soldiers also complained of having to use lights during the night missions to fuel and de-fuel the AV. The problem of fueling operations at night arises from the operator not being able to observe if there are any air bubbles in the fuel lines. Trapped or introduced air can cause the engine to stall and fail during flight. Detailed tactical operational tasks and checks results are included in Soldier questionnaire results (appendix B).

3.8 Autonomous/Manual Fight Missions

Soldiers rated all automated/manual flight mission tasks between easy and extremely easy during day and night, except for resuming a flight plan which was rated between neutral and easy. Soldiers commented that the AV was slow to respond to manual commands. All Soldiers stated that the design of the manual control icons accurately reflected the action they are intended to produce. Soldiers' overall rating for the g-MAV during the missions was between neutral and good. Comments from the overall rating questionnaire highlighted that the OCU crashing or freezing was a major reliability problem. Detailed autonomous/manual flight mission results are included in Soldier questionnaire results (appendix B).

3.9 Mission After-Action Reviews (AAR)

Most leaders and operators surveyed stated that the g-MAV system was suitable and effective for each type mission conducted. Most commented that when operating properly, the g-MAV served as a valuable reconnaissance tool.

When asked if the g-MAV could be improved to better help accomplish the mission, most of the Soldiers recommended an easier fueling/de-fueling method, longer flight times, gimbaled cameras with pan-and-tilt capabilities, and reduced noise signature as improvements in the system's capabilities. Detailed AAR results are included in Soldier questionnaire results (appendix B).

3.10 End of Test Results

Upon completion of the experiment, Solders rated the tasks and characteristics of the g-MAV using the following 7-point scale. Table 1 depicts the ratings based on the Soldiers' cumulative experience of operating the g-MAV system.

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

Results are as follow: (sample size = 13).

Table 1. End of test ratings.

Task or Characteristic	Mean Response
1. Unpacking components	6.36
2. Assembling the system	6.17
3. Starting the air vehicle	4.67
4. Operating the OCU	5.08
5. Controlling the air vehicle via the touch screen	5.00
6. Creating/modifying flight plans	5.58
7. De-fueling/fueling operations	4.18
8. Troubleshooting procedures	4.33
9. Backpacking the system	6.00
10. Compatibility with clothing and equipment	5.25
11. Durability of the system	2.64
12. Maintainability of the system	3.17
13. Reliability of the system	2.25
14. System malfunctions resulting in lock-up, power down, etc.	2.83
15. Ability to control and maintain camera orientation during flight	3.58
16. Technical manual	4.85
17. Operating range and time	3.42
18. Battery charging procedures/operations.	4.80
19. Quality of camera images received.	5.25
20. Disassembling the system	6.17
21. Packing the components for transport	5.92
22. Component storage cases	6.00

System reliability and durability were rated lowest, based on the numerous system malfunctions experienced throughout the conduct of the assessment. Most of the Soldiers surveyed agreed that the g-MAV improves mission effectiveness when the system is working properly. Improved durability, longer flight times, and gimbaled cameras with pan-and-tilt capabilities were primary recommendations for system improvements. Detailed end-of-test results are included in Soldier questionnaire results (appendix B).

4. Summary

4.1 Discussion and Conclusions

When operating properly, the g-MAV system enhanced or increased situational awareness by identifying and confirming enemy positions, personnel, and vehicles without exposing Soldiers to unnecessary risk. The platoon leader and his subordinate leaders believe the g-MAV system demonstrated the greatest military utility in support of the leader's reconnaissance followed by route and area reconnaissance missions. The platoon leader stated, "The g-MAV was a valuable asset during the leader's reconnaissance because it allowed me to gain and maintain 'eyes on the objective,' identify enemy personnel and determine their strength and locations, and detect targets

at extended ranges, allowing the platoon to maneuver out of contact to a position of tactical advantage."

Areas requiring improvement include system reliability, durability, and operator proficiency. Soldiers experienced significant reliability and durability problems when they employed the g-MAV. Of the 32 tactical flights planned during the mission trials, 22 were actually completed. Ten aborted flights occurred during launch attempts. Software, hardware, or other technical problems with the system attributed to all ten aborted flights.

Also at issue throughout the MUA was operator proficiency. During each operational mission, Honeywell personnel had to assist the operator in order to launch the AV. The operator training course taught by Honeywell engineers was difficult for some of the operators to comprehend, recall, and apply. The abundance of information presented during the one-week course was overwhelming for some operators. Specific procedures that were problematic for the Soldiers were engine tuning, reconfiguration of radios, pre-flight checks, and avionics pod interchange procedures. Extending the operator training course beyond one week and restructuring the training to focus more time on areas where Soldiers demonstrated performance deficiencies were identified as a recommendation to increase operator proficiency.

Appendix A. Soldier Demographics (operators)

SAMPLE SIZE (N) = 4

RANK	MOS	YEARS IN SERVICE
E-3 - 3 E-4 - 1	19D - 4	18 months (mean) (Range is 16 to 20 months)

1. Do you smoke? _2_ Yes _2_ No

2. Do you wear prescription lenses? _1_ Yes _3_ No

   a. If yes, which do you most often wear? _0_ Glasses _1_ Contacts

   b. Which do you wear while firing a weapon? _0_ Glasses _1_ Contacts

3. With which hand do you most often write? _4_ Right _0_ Left

4. With which hand do you most often fire a weapon? _4_ Right _0_ Left

5. What is your height? _69.5_ inches (range is 68 – 72 inches)

6. What is your weight? _166_ pounds (range is 147 – 186 lb)

7.a. How often do you use a computer?

_4_ daily _0_ occasionally _0_ infrequently _0_ do not use one

   b. How often do you use a computer on a weekly basis?

_0_ None _1_ 1-10 hours _3_ 11-20 hours _0_ 21-30 hours
___ More than 30 hours per week

   c. If you use a computer, please explain for what uses/programs:

_2_ word processing _1_ database _1_ spreadsheet
_3_ internet _1_ games _0_ other

   d. Please identify your access to a computer:

_4_ own my own computer _0_ use unit computer
_0_ use friend's computer _0_ use at library
_0_ do not own computer

8. What is your computer experience skill level?

_0_ None _1_ Novice _2_ Intermediate _1_ Advanced

9. Do you have experience with any type of digital or electronic military displays (e.g. FBCB2, fire control systems (ITAS, IBAS), etc.)

_1_ Yes _3_ No

Comments	**Responses**
FBCB2	1

10. Do you have experience with any type of remote controlled vehicles or remotely controlling any mechanical device? _0_ Yes _4_ No

11. Have you played flight simulation games? _2_ Yes _2_ No

12. Have you used a touch screen to play either video or computer games?
_1_ Yes _3_ No

13. Do you become more fatigued when viewing a computer screen or display for prolonged periods of time? _0_ Yes _4_ No

14. What is your typing experience skill level?

_0_ None _1_ Novice _2_ Intermediate _1_ Advanced

15. What type of mouse or input device do you prefer to move around the screen or to select objects with?

_0_ Do not use
_1_ 3-button
_0_ Joystick
_0_ No preference
_1_ Scroll wheel
_0_ Touch pad
_1_ 2-button
_0_ Roller ball
_1_ Touch screen (stylus)

16. What is your preference (select one) for selecting information from a computer screen display?

_0_ Do not use
_1_ All selections visible at once
_0_ No preference
_3_ drop down menu
_0_ other

17. Are you color blind or have problems distinguishing between colors, for example like those used for a military map?

_0_ Yes _4_ No

18. If you use a computer for both games and other tasks (word processing, internet, etc.), please identify what the majority of use is:

_1_ Do not use for both _1_ More "other tasks" than games
_0_ Equal for both _2_ More games than "other tasks"

19. Do you have experience with military unmanned aerial vehicles?

_0_ Yes _4_ No

20. How long have you been assigned to your current unit?

_0_ Years _11.5_ Months

21. How long have you been assigned to your current duty position?

_0_ Years _9.5_ Months

22. Do you have combat experience?

_0_ Yes _4_ No

23. What was the last military profession development course you completed?

_3_ AIT _1_ PLDC

24. Using the scale below, rate your level of experience in the following individual and collective tasks:

1	2	3	4	5	6	7
Extremely Low	Very Low	Low	Neutral	High	Very High	Extremely High

INDIVIDUAL TASKS	**MEAN**
1. Map Reading	4.50
2. Land Navigation	4.50
3. General Reconnaissance Skills	4.50
4. Reconnoiter a Built Up Area	4.20
5. Conduct a Route Reconnaissance	4.20

SOLDIER DEMOGRAPHICS (PLATOON MEMBERS)
SAMPLE SIZE (N) = 11

RANK	**MOS**	**YEARS IN SERVICE**
E-2 - 1 E-6 - 3 E-3 - 2 E-7 - 1 E-4 – 1 0-2 - 1 E-5 - 2	19D - 11	5 Years 5 Months (mean) (Range is 1 to 17 years)

1. Do you smoke? _6_ Yes _5_ No

2. Do you wear prescription lenses? _3_ Yes _8_ No

   a. If yes, which do you most often wear? _3_ Glasses _0_ Contacts

   b. Which do you wear while firing a weapon? _3_ Glasses _0_ Contacts

3. With which hand do you most often write? _10_ Right _1_ Left

4. With which hand do you most often fire a weapon? _10_ Right _1_ Left

5. What is your height? _68.8_ inches (range is 61 – 74 inches)

6. What is your weight? _183_ pounds (range is 160 – 200 lb)

7.a. How often do you use a computer?

_9_ daily _2_ occasionally _0_ infrequently _0_ do not use one

   b. How often do you use a computer on a weekly basis?

_0_ None _5_ 1-10 hours _4_ 11-20 hours _1_ 21-30 hours
_1_ More than 30 hours per week

   c. If you use a computer, please explain for what uses/programs:

_6_ word processing _3_ database _4_ spreadsheet
11 internet _7_ games _0_ other

   d. Please identify your access to a computer (check all that apply):

_11_ own my own computer _6_ use unit computer
_1_ use friend's computer _0_ use at library
_0_ do not own computer

8. What is your computer experience skill level?

_0_ None _2_ Novice _8_ Intermediate _1_ Advanced

9. Do you have experience with any type of digital or electronic military displays (e.g. FBCB2, fire control systems (ITAS, IBAS), etc.)

_10_ Yes _1_ No

Comments	**Responses**
FBCB2	10
LRAS	3
CLU	2
ITAS	1
DAGR	1

10. Do you have experience with any type of remote controlled vehicles or remotely controlling any mechanical device? _3_ Yes _8_ No

Remote Control Car	3

11. Have you played flight simulation games? _9_ Yes _2_ No

12. Have you used a touch screen to play either video or computer games?

_3_ Yes _8_ No

13. Do you become more fatigued when viewing a computer screen or display for prolonged periods of time? _2_ Yes _9_ No

14. What is your typing experience skill level?

_0_ None _3_ Novice _7_ Intermediate _1_ Advanced

15. What type of mouse or input device do you prefer to move around the screen or to select objects with?

_0_ Do not use
_1_ 3-button
_0_ Joystick
_2_ No preference
_1_ Scroll wheel
_0_ Touch pad
_5_ 2-button
_1_ Roller ball
_3_ Touch screen (stylus)

16. What is your preference (select one) for selecting information from a computer screen display?

_0_ Do not use
_2_ All selections visible at once
_1_ No preference
_8_ drop down menu
_0_ other

17. Are you color blind or have problems distinguishing between colors, for example like those used for a military map?

_0_ Yes _11_ No

18. If you use a computer for both games and other tasks (word processing, internet, etc.), please identify what the majority of use is:

_0_ Do not use for both _7_ More "other tasks" than games
_1_ Equal for both _3_ More games than "other tasks"

19. Do you have experience with military unmanned aerial vehicles?

_0_ Yes _11_ No

20. How long have you been assigned to your current unit?

_1_ Years _3_ Months

21. How long have you been assigned to your current duty position?

_1_ Years _3_ Months

22. Do you have combat experience?

_5_ Yes _6_ No

23. What was the last military profession development course you completed?

_5_ AIT _3_ PLDC _1_ BNCOC _1_ ANCOC _1_ SCL

24. Using the scale below, rate your level of experience in the following individual and collective tasks:

1	2	3	4	5	6	7
Extremely Low	Very Low	Low	Neutral	High	Very High	Extremely High

INDIVIDUAL TASKS	**MEAN**
1. Map Reading	5.00
2. Land Navigation	4.90
3. General Reconnaissance Skills	5.00
4. Reconnoiter a Built Up Area	4.90
5. Conduct a Route Reconnaissance	4.90

Appendix B. Soldier Questionnaire Results

POST TRAINING

SAMPLE SIZE (N) = 11

1. Using the scale below, please rate the following areas of training.

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

TRAINING AREA	MEAN
1. Description of features and capabilities of the system	5.70
2. Description and use of each component	5.60
3. Demonstration on how to use the system	5.70
4. Information on how to maintain the system	5.20
5. Description of tactical employment considerations	5.30
6. Training/technical manual	6.20
7. Training on how to assemble the system and place into operation	6.50
8. Training on how to take the system out of operation, disassemble and pack the system.	6.50
9. Lecture to hands-on instruction ratio	4.60
10. Training aids/slides/practical exercises	5.70
11. Handout material	6.10
12. Length of training	6.00
13. Level of detail of training	5.80

Comments	Responses
4) I have concerns with the durability and long-term maintenance due to the amount of plastic, i.e., the plastic clips will crack over time.	1
4) The AV that crashed fell about 20-25 ft from the ground and was completely destroyed.	1
4) I may have missed some classes on this but what about cleaning of the AV, upkeep of engine or body parts, general maintenance?	1
5) Tactical employment considerations were not g-MAV specific. Some specific employment considerations need to be developed for the g-MAV. 9) More hands on is always better when into operations. Senior Leaders benefit more from the lecture.	1
9) It was pretty good but it would be nice to have OCUs and GDTs in hand while learning about them.	
9) I learned twice as much doing hands-on in the field.	2
Classroom instruction is good but hands-on simulator training is better.	1
Everything in New Mexico gradually got better as the week went on. The only thing that threw me off was a little too much detail that the Kestrel[1] would be useful for. I also thought when we got into the OCU it would have been better to one OCU per person.	1

[1]Kestrel, which is a registered trademark of Nielsen-Kellerman, is a wind and weather instrument.

2. Do changes need to be made to this instruction? _6_ Yes _5_ No

Comments	Responses
Could show how to use OCU and all the features.	1
Less slide presentation and more hands-on.	1
More flying time would be better. Get a little more daring and let us learn how to do some lower altitude stuff. Especially in the urban area.	1
More operator hands-on. A little more detail needed on maintenance of the system.	1

3. What did you like **best** about the g-MAV system training?

The flying. Having the instructor right next to you is nice in case you have a question. The instructor changing stuff up in the mission instead of just flying a circle and landing.	1
The amount of flight given to operators was much better.	1
The amount of flight time we had combined with the simulator training.	1
The number of flights we were able to attain. All operators flew more than the required number of flights, which made them more proficient than just flying the basic flights.	1
How everything was laid out and gone over.	1
I like landing on top of a building the best. More freedom to do what I wanted would have also helped the course.	1
Receptiveness and responsiveness of the trainers.	1
The hands-on made the training better and the system easier to understand.	1

4. What did you like **least** about the g-MAV system training?

The constant changes of schedule, and lack of g-MAVs.	1
Not enough freedom to do what we want with the vehicle.	1
Poor time management. We had AVs sitting back in the training building instead of at the training site. We sat around waiting our turn.	1
The class on theory of flight went over every Soldier's level of understanding.	1
We could've used more equipment so that everyone can look at the system while it's being taught.	1

5. Using the scale below and based on the training received, please rate your "level" of agreement with each statement.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

	MEAN
1. I feel confident I can unpack and assemble the system	4.80
2. I feel confident I can disassemble the system and re-pack it.	4.80
3. I feel confident I can perform the pre-flight inspection	4.80
4. I feel confident I can start the air vehicle	4.90
5. I feel confident I can fly the system manually	4.90
6. I feel confident I can upload a flight plan and fly the system autonomously	4.50
7. I feel confident I can develop my own flight plan and fly the system autonomously	4.50
8. I feel confident I can suspend and resume a flight plan	4.80
9. The icons on the toolbars are intuitive and easy to understand and identify	4.20
10. The toolbars are easy to bring up and close	4.60
11. I feel confident I can select which display to view in the main window	4.80
12. The OCU is easy to understand, well designed, and easy to operate.	4.40
13. I feel confident I can perform corrective action, solve the problem, and return the system to a working state.	4.10
14. The g-MAV system is safe to operate and use.	3.90
15. The g-MAV system can be rapidly set up for operational use.	4.20
16. The training and the manuals provided with the g-MAV system are sufficient.	4.30

Comments	**Responses**
This system is fairly easy to use.	1
1 and 2) As far as emplace displace it's very easy.	1
6,7,9,10) With more practice I will grow to a comfortable level.	1
12) Glare on the screen is a problem. The sun shield is OK but needs some sort of stiffer to hold it up. The strings from the case get in the way of seeing the screen and using the touch pen.	1
12) The cord to the pen is not long enough.	1
13) We are not trained on in-flight emergency procedures or how to identify in-flight mechanical problems, i.e., engine sputtering.	1
13) There have been instances when the g-MAV has began acting strange in the air, such as when the engine has sputtered or the wind has moved the MAV so that the operator has no control. I am not sure if beginning operators can respond quickly or effectively.	1
14) Two crashes in 2 days that were mechanical failures makes the g-MAV unsafe.	1

Comments	Responses
It has been about 3 weeks since New Mexico and I have kind of forgotten how to do an autonomous flight. I remember some things but would need some help. That's when an OCU for everyone would have helped. More time with it would have been great.	1
The weakest link in the system is the fuel/defuel process. I don't believe that this system is tough enough to survive the average Soldier.	1
Training needs to be more on our own to explore once we know how to fly and use the AV rather than an instructor telling us every little thing to do.	1

EMPLACE AND DISPLACE TRIALS

SAMPLE SIZE (N) = 6 (Post training)

1. Using the scale below, please rate your ability to perform the following tasks during this mission.

EMPLACEMENT

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

AIRCRAFT ASSEMBLY	MEAN
1. Opening all containers/packs	5.67
2. Removing AV from transport carrier	6.00
3. Removing Starter Hub, Starter Legs and Foot Braces from transport carrier	5.33
4. Verifying that starter latches are secure	6.17
5. Connecting and Locking Starter Hub to Starter Base and Screwing in Starter Legs	5.50
6. Connecting Landing Gear to AV	5.67
7. Inserting Foot Brace to Starter Base	6.17
8. Removing Pods from transport carrier	5.50
9. Connecting Avionics Pod to AV	5.67
10. Attaching lower straps to Avionics Pod	5.67
11. Connecting Payload Pod to AV	5.67
12. Attaching lower straps to Payload Pod	5.67
13. Installing battery, if required	6.00
GROUND STATION ASSEMBLY	
14. Connecting OCU to GDT	5.83
15. Tightening antennas and adjusting them straight up	5.60

Comments	Responses
3) Starter carrier bag could be larger.	1
13) Batteries are easy to install but wires get bent and can break.	1
Padding on zippers sometimes gets caught. Even when tightened, the antennas are still able to move.	1
Antenna on the GDT needs a holding pin; it's going to get broke if you try to pull it out in a hurry.	1
I never learned how to disconnect the cables on the GDT and didn't do it in previous assemblies.	1

AIR VEHICLE EXTERIOR CHECK	MEAN
16. Checking for loose fasteners: (Muffler bolts, Engine bolts, Avionics Pod screws, Payload Pod screws)	5.83
17. Checking Air Filter (clean and secure)	6.00
18. Checking fuel lines for secure connection	5.83
19. Checking Pods (secure and tight connection)	6.00
20. Checking Landing gear (secure and locked in place)	5.83
21. Rotating fan to ensure no binding with duct	6.00
22. Checking fan for chips/cracks.	6.17
23. Checking vanes/stators for chips/cracks	6.17
24. Verifying starter latches are secure	6.33
25. Checking Antennas (tight and pointed in correct directions)	5.50

Comments **Responses**

25) Antennas don't seem to tighten when I'm adjusting them 1

AIRCRAFT POWER UP	MEAN
26. Checking GPS Zeroize switch (DOWN)	6.17
27. Checking Remote Launch switch (DOWN)	6.17
28. Checking Servo Enable switch (DOWN)	6.17
29. Moving Power switch (UP)	6.17
30. Powering up: Checking for FLASHING RED LED	6.00
31. Initializing: Checking for SOLID GREEN and RED LED	5.33
32. Ready for Servo Test: Checking for SOLID GREEN LED	6.00
GROUND STATION POWERUP	
33. Checking Zeroize switch (down)	6.00
34. Checking OCU-GDT Data cable to OCU Disconnected	6.00
35. Turning On OCU Power (OCU led #4: solid blue)	6.33
36. Connecting OCU-GDT Data cable	5.83
37. Pressing " start GCS" to initialize software	6.60
38. Setting AV ID and Comm. channel	5.80
39. Set lost link response and time	6.40
40. Set fuel load	5.67
41. Checking GCS and aircraft status.	6.20
42. Verify aircraft battery life is sufficient for mission.	5.25
43. Checking intervisibility for potential lost link areas.	5.67
44. Checking GCS preflight status on aircraft.	6.25

Did not complete emplacement because I forgot to connect the GDT. 1
I had some problems with getting a communication link on the GDT. 1

SERVO TEST / ENGINE ENABLE	MEAN
45. Checking Servo switch (UP)	6.33
46. Checking all 5 servos move without any binding	6.33
47. Checking LED for SOLID GREEN	5.67

DISPLACEMENT

AIRCRAFT POWER DOWN	MEAN
48. Setting Power switch: DOWN	5.50
49. Setting Servo switch: DOWN	5.50
50. Check Remote Launch switch: DOWN	5.50
51. Check Zeroize switch: DOWN	5.50
GROUND STATION POWER DOWN	
52. Check Zeroize switch: UP	5.50
53. On OCU, selecting “File -> Shutdown”	5.40
AIR VEHICLE DISASSEMBLY	
54. Detaching Lower Red rubber straps from Payload Pod	6.33
55. Disconnecting Payload Pod from AV	6.50
56. Detaching Lower Red rubber straps from Avionics Pod	6.17
57. Disconnecting Avionics Pod from AV	6.50
58. Inserting Pods into transport carrier	6.33
59. Removing Foot Braces from Starter Base	6.50
60. Disconnecting landing gear from aircraft	6.17
61. Disconnecting and unlocking Starter Hub from Starter Base	6.33
62. Unscrewing Starter Legs from Starter Base	6.17
63. Inserting Starter Hub, Legs, and Foot Braces into transport carrier	4.67
64. Attaching aircraft to starter base	6.00
65. Inserting AV into transport carrier	6.50

Comments	Responses
The bag for the starting gear needs to be bigger.	3

GROUND STATION DISASSEMBLY	MEAN
66. Disconnecting OCU from GDT	6.50
67. Positioning Radio Antennas: DOWN	6.50
68. Packing for transport	6.50

PACKING FOR TRANSPORT	MEAN
69. Opening all containers/packs	6.33
70. Stowing Air Vehicle	6.50
71. Stowing starters	6.33
72. Stowing Ground Control Station	6.33
73. Stowing Ground Data Terminal	6.33
74. Stowing Operator Control Unit	6.33
75. Closing all containers/packs	5.67

2. Please rate the following characteristics of the g-MAV you used during the trial.

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

	MEAN
1. Size of each component.	5.67
2. Weight of each component.	6.00
3. Shape of components.	6.00
4. Storage location of components.	5.00
5. Access to components when stored.	6.00
6. Assembly/mating of components.	5.83
7. Compatibility with clothing and equipment.	6.17

Comments	Responses
Number 4 OCU does not fit in AV bag.	1
The Styrofoam in pod boxes gets caught in connectors.	1
The bag for landing and starting gear could be bigger. A slot for the GDT antenna to go in to prevent breaking.	1

3. Was there anything about an individual component or task during this trial that made unpacking, placing into operation, or packing more difficult?

YES	NO
2	4

The GPS system is a little sensitive; I burned a minute and a half just waiting on it.	1
Bag Sizes (too small for the starter).	1

4. Was there anything about the g-MAV system during this trial that made it unsafe for you to use or unsafe to others during the trial?

YES	NO
0	6

ENGINE TUNING EXERCISE

SAMPLE SIZE (N) = 6

1. Using the scale below, please rate your ability to perform the following tasks.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

	MEAN
1. Determining requirements for engine tuning based on environmental conditions and engine performance.	5.50
2. Monitoring LED display window for indicator lights and status.	6.25
3. Turning needle valve adjustment screws to desired position.	5.88
4. Activating servo enable switch.	6.75
5. Activating AV power-up switch.	6.75
6. Activating remote launch switch.	6.75
7. Determining whether or not the low-end mixture requires tuning.	5.50
8. Determining whether or not the high-end mixture requires tuning.	5.50
9. Ability to distinguish RPM pitch based on sound.	5.75
10. Verifying proper tuning has been performed.	5.50
11. Testing the system for proper operation.	5.75

Comments	**Responses**
9) Different people hear different things.	1
Hearing the engine go from high to low pitch was simple and I could tell when it was tuned properly.	1
Too dependent on environment and tuner's ear.	1
LED display is kind of difficult to see in the sunlight.	1

2. Please rate the following characteristics of the g-MAV system you tuned during the trial

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

	MEAN
1. Completeness and accuracy of engine tuning steps and procedures outlined in the technical manual.	6.13
2. Access to all components.	5.88
3. Location of servo enable switch.	6.13
4. Location of AV power-up switch.	6.13
5. Location of LED indicator window display.	5.75
6. Location of high-end needle valve adjustment screw.	5.63
7. Location of low-end needle valve adjustment screw.	5.63
8. Location of remote launch switch.	5.75
9. Availability of required tools.	6.50

3. Was there anything about an individual component or task during this trial that made tuning the engine more difficult?

YES	NO
2	4

Comments	Responses
It could be a little more useful to have the valve screws near the switches and LED window. The way it is now, we have to keep walking around.	1
The control unit hanging off your chest.	1

4. Was there anything about tuning the g-MAV engine during this trial that made it unsafe for you or unsafe to others?

YES	NO
0	6

FLIGHT PLANNING

SAMPLE SIZE (N) = 7

1. Using the scale below, please rate your ability to perform the following flight planning tasks during this trial.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

	MEAN
1. Opening a workspace	6.42
2. Creating a workspace	6.25
3. Importing/Exporting a workspace	6.09
4. Creating new flight plan	6.36
5. Identifying the flight plan	6.42
6. Selecting newly identified flight plan	6.36
7. Opening flight plan toolbar	6.33
8. Selecting waypoint type	6.36
9. Identifying map location for the waypoint	6.33
10. Opening the waypoint editor	6.27
11. Verifying flight plan against the rules and guidelines to creating a flight plan	6.45
12. Verifying communication set-up is correct.	6.42
13. Verifying lost link response is correct.	6.42
14. Verifying altitude limits are correct.	6.25
15. Entering ambient air temperature data.	6.00
16. Entering wind data.	5.75
17. Checking wind speed	6.33
18. Adding a pattern to the flight plan.	6.17
19. Editing waypoints.	6.64
20. Adding and editing points of interest.	6.13
21. Uploading a flight plan	6.58
22. Sending flight plan to AV	6.75

Comments	Responses
The flight planning works out well. There are some things that take time to learn how and where they are, but it becomes easier the more you do it.	1
When we tried to import the workspace onto the OCU, It did not bring up the correct flight plan.	1

2. Was there anything about an individual task during this trial that made planning more difficult?

YES	NO
1	6

Comments	Responses
OCU completely cut off in the middle of the flight plan. I used different OCU and had to fly manually without my flight plan.	1

3. Taking everything into consideration, what is your overall rating of the flight planning tasks of the g-MAV?

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

MEAN
5.75

It pretty much only takes knowing how to use the OCU, then it does its job. The OCU is good the way it is.	1
My first time with using a flight plan and after I had set it up, it went well.	1

TARGET DETECTION

SAMPLE (N) = 11 DAY AND 4 NIGHT

1. Using the scale below, please rate your ability to perform the following tasks.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

TASK	DAY	NIGHT
1. Maneuvering g-MAV into area of interest	4.60	6.67
2. Controlling g-MAV's rotation direction and speed	4.91	6.50
3. Controlling and using the forward and downward looking cameras for target detection	4.70	6.00
4. Taking a snapshot image of the target	4.00	6.00
5. Identifying the target	4.11	4.75
6. Identifying the location of the target	5.56	6.00

Comments	**Responses**
DAY	
AV executed Lost Link Response so video was cutting in and out	*1*
1 and 2 lost capability to maneuver the g-MAV due to the OCU not taking commands and the g-MAV not responding to commands.	*1*
4) Hard with the wind and blurry with the GDT antenna direction	*1*
5) The g-MAV has to be too high up to keep it steady to be able to view the town and to zoom the wind is a big factor. 6) Sometimes you will have to hover the bird too long to keep it steady and get a picture.	*1*
During the flight while I was using downward camera, my screen split into two screens with a black line in the middle of the OCU. It did correct itself. MAV moves around on its own so it makes it hard to stay on target.	*1*
It was too windy to make out what anything was. To me I didn't think it was very windy at all but the MAV was not capable of handling easy weather conditions.	*1*
Moving g-MAV down the road was a little difficult because of wind it would venture off the road a little then I would have to bring it back on. When I used downward camera, it was a little shaky so zooming in was difficult to stay on a target location.	*1*
My OCU had no video at all but the Stryker VDT (video data terminal) did. I flew from the VDT screen when video wasn't cutting out and water drops were also formed on forward looking camera so I could not see with that camera. Downward camera eventually had water on it too.	*1*
NIGHT	
No. 5 Targets look like blobs. Can identify as vehicle or person but no finer details.	1
3 and 4 IR picks up target well but has no detail to actually identify target.	1
Multiple people standing close to each other just look like a large hot spot with the IR Pod	1

2. Using the scale below, please rate the effectiveness of the following characteristics

1	2	3	4	5	6	7
Extremely Ineffective	Very Ineffective	Ineffective	Neutral	Effective	Very Effective	Extremely Effective

CHARACTERISTIC	TAC MSN DAY	TAC MSN NIGHT
1. Clarity and resolution of video image for target detection purposes	3.56	4.25
2. Stability of image during target detection trial	2.38	5.00
3. Brightness control/adjustment	6.50	5.67
4. Contrast control/adjustment	6.50	5.67

Comments	**Responses**
DAY	
1) Camera is (good) but I can see twice as much with the LRAS-3[2] At an OP.	*1*
2) A gimbaled camera would be handy so there is not as much time spent hovering to get a good picture with the zoom.	
I kept having trouble with video link. It kept getting fuzzy. MAV moves around on its own sometimes.	*1*
Imaging was cutting in and out. Wind was a problem	*1*
IR is blurry and couldn't keep a clear picture	*1*
It was shaky so it was hard to zoom in.	*1*
Very unsafe with any wind.	*1*
Video kept cutting in and out also would seemed to be blowing around.	*1*
Water formed on both cameras when my video did work so it was hard to see when I did have video.	
NIGHT	
No. 1 image is fuzzy. Not enough detail. Image is often useless due to bad signal.	1
The second flight was extremely blurry; the third flight was good until we got a ghost image.	1

3. Did you experience any eyestrain or headache after viewing the display for a period of time?

	YES	NO
DAY	0	11
NIGHT	0	4

4. Were you able to view the display at a comfortable distance and could you view the display from that distance long enough to identify the target?

[2]Long-range advanced scout surveillance system

	YES	NO
DAY	8	3
NIGHT	4	0

Comments	**Responses**
DAY	
I had no video and OCU turned completely off. When I did have video, water droplets were on the camera and I was not able to see anything.	*1*
Could not make out exactly what things were or what objects might have.	1

DISPLAY

SAMPLE SIZE (N) = 4

1. Using the scale below, please rate your ability to perform the following tasks.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

TASK	MEAN
1. Changing the display for left or right handed preference	6.33
2. Selecting which image to be viewed in main display area	6.50
3. Selecting which image to be viewed in inset display area	6.00
4. Swapping images from main display area and inset display area	6.67
5. Selecting map or video only	5.25
6. Identifying the location of the g-MAV	6.50
7. Identifying the altitude of the g-MAV	6.50
8. Identifying the heading (direction of g-MAV)	6.25
9. Identifying the location of the GCS	4.50
10. Using the pen stylus with the touch screen	7.00
11. Entering text using the pop-up keyboard	6.33

Comments	Responses
The pen stylus is not very accurate.	1
Had to use drop-down menu double tapping screen didn't work.	1
I lost an antenna and lost IR camera during night so it made it a little bit more difficult to actually locate the exact AV position.	1

2. Using the scale below, please rate the effectiveness of the following characteristics.

1	2	3	4	5	6	7
Extremely Ineffective	Very Ineffective	Ineffective	Neutral	Effective	Very Effective	Extremely Effective

CHARACTERISTIC	MEAN
1. Allocation of screen space (size) for each of the various screens, toolbars, status displays. (Your ability to view the area and gather the information you needed from it)	6.50
2. Size of text and your ability to read the text in each of the various areas	6.50
3. Colors used within each of the various screen sections	6.00
4. Utility or usefulness of each of the various screen areas	6.75
5. Brightness control/adjustment	7.00
6. Contrast control/adjustment	7.00
7. Shapes and symbols used for the various icons	6.50
8. Responsiveness of the display when scrolling	6.67
9. Cautions, warnings and alerts	6.25

3. Was there information that was needed but not available?

YES	NO
0	4

4. Was there any information presented that was not needed?

YES	NO
0	4

5. Did you experience any eyestrain or headache after viewing the display for a period of time?

YES	NO
1	3

6. Does operating the g-MAV system adversely affect your performance in a field environment? (e.g., fatigue, situational awareness)?

YES	NO
0	4

7. Were you able to view the display at a comfortable distance and could you view the display from that distance for long periods of time?

YES	NO
4	0

TACTICAL OPERATIONAL TASKS AND CHECKS
TACTICAL MISSIONS

SAMPLE (N) = 11 DAY

SAMPLE (N) = 4 NIGHT

1. Using the scale below, please rate your ability to perform the following tasks during this mission. When assigning a rating, consider all the steps identified related to the task.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

	MEAN	
EMPLACEMENT	**DAY**	**NIGHT**
1. LAUNCH and RECOVERY AREA CHECK: Checking area – suitable for flight operations, using hand-held GPS (if available) to verify availability of GPS signal at launch and recovery areas, checking for overhead obstructions, and checking for FOD (foreign object damage)	5.22	6.25
2. AIRCRAFT ASSEMBLY: Opening all containers/packs; removing AV from transport carrier; removing Starter Hub, Starter Legs and Foot Braces from transport carrier; screwing in the Starter Legs to Starter Base; connecting and Locking Starter Hub to Starter Base; connecting Landing Gear to AV, inserting Foot Braces to Starter Base; removing Pods from transport carrier; connecting Avionics Pod to AV; connecting Payload Pod to AV; and installing battery, if required	7.00	6.25
3. GROUND STATION ASSEMBLY: Connecting OCU to GDT and tightening antennas and adjusting them straight up	7.00	6.00
PREFLIGHT	**DAY**	**NIGHT**
4. FUELING DE-FUELING VEHICLE: Pre-mixing fuel, placing hand on duct to equalize any static electricity build up, disconnecting fuel line on AV, connecting one fuel line from fueling device to AV fuel line, connecting other fuel line from fueling device to fuel canister, opening valve on fuel line leading to AV, extracting any residual fuel and air into fueling device, closing valve leading to AV, opening valve on fuel line leading to fuel canister, purging excess fuel and air into fuel canister, extracting fuel from fuel canister into fueling device, closing valve leading to fuel canister, opening valve leading to AV, purging fuel from fueling device into AV, check AV for leaking fuel, and reconnecting fuel line on AV	6.09	3.25
5. AIR VEHICLE EXTERIOR CHECK: Checking for loose fasteners: (Muffler bolts, Engine bolts, Avionics Pod screws, Payload Pod screws), checking Air Filter (clean and secure), checking Pods (secure and tight connection), checking Landing gear (secure and locked in place), checking upper and lower straps for signs of wear and tear, rotating fan to ensure no binding with duct, checking fan for large chips/cracks, checking vanes/stators for large chips/cracks, checking duct for large chips/cracks, and checking Antennas (tight and pointed straight down)	7.00	5.50

(cont)

	MEAN	
	DAY	**NIGHT**
6. GROUND STATION POWERUP: Checking Zeroize switch (UP), verifying GDT connection to OCU, turning On OCU Power, allowing software to initialize, and setting AV ID	6.45	5.75
AIRCRAFT POWER UP	**DAY**	**NIGHT**
7. AIRCRAFT POWER UP: Checking Zeroize switch (DOWN), checking Remote Launch switch (DOWN), checking Servo switch (DOWN), moving Power switch (UP), powering up: Checking for FLASHING RED LED, initializing: Checking for SOLID GREEN and RED LED, and ready for Servo Test: Checking for SOLID GREEN LED	7.00	5.75
SERVO TEST / ENGINE ENABLE	**DAY**	**NIGHT**
8. SERVO TEST / ENGINE ENABLE: Checking Servo switch (UP), checking all 4 vane servos move in the same direction and throttle servo moves without any binding, and checking LED for SOLID GREEN	7.00	5.75
9. ENGINE PRIME / START: Verifying that fuel line is connected, setting Choke: FULL UP (closed), placing hands on top of air filter or use handle, placing foot in Foot Braces on Starter and shin against side of duct, pulling rip cord until engine pops, setting Choke: DOWN (open), placing hands on top of air filter or use handle, placing foot in foot braces on starter and shin against side of duct, pulling rip cord until engine starts, checking for removal from starter: SOLID GREEN and FLASHING RED LED, unscrewing starter screws, lifting AV from starter and placing AV on ground, clearing launch area minimum of 50 ft and carrying starter and transport gear	7.00	6.00
LAUNCH	**DAY**	**NIGHT**
10. AUTONOMOUS LAUNCH: Uploading flight plan to Air Vehicle, send uploaded flight plan to Air Vehicle, and executing flight plan	4.50	6.25
11. MANUAL LAUNCH: Pressing the "Launch" icon on the "Flight Command" toolbar" and pressing the "Send Command to Aircraft" icon on the "Flight Command" toolbar"	7.00	5.50
12. REMOTE LAUNCH: Setting Remote Launch switch: UP, setting Remote Launch switch: DOWN, and checking for LED: FLASHING GREEN	7.00	NA
IN-FLIGHT	**DAY**	**NIGHT**
13. MANUAL COMMANDS (ROSETTE): Inserting Left/Right commands, inserting Forward/Aft commands, inserting Up/Down commands, and inserting Rotate Left/Right commands	6.18	6.50
14. SUSPEND and RESUME FLIGHT PLAN: Suspending flight plan (pressing STOP icon and SEND icon) and resuming flight plan (pressing GO icon and SEND icon)	5.20	6.50
15. GO-TO (ON PATH): Pressing the "Go-To" icon on the "Flight Command" toolbar", selecting a non sequenced waypoint from the flight plan, and pressing the "Send Command to Aircraft" icon on the "Flight Command" toolbar"	6.33	6.67

(cont)

	MEAN	
	DAY	**NIGHT**
16. GO-TO (OFF PATH): Pressing the "Go-To" icon on the "Flight Command" toolbar", selecting a desired location on the map, and pressing the "Send Command to Aircraft" icon on the "Flight Command" toolbar"	5.89	6.67
17. VIDEO RECORD / PLAYBACK/ FAST FORWARD / REWIND: Switching to video view mode and selecting the desired icon of choice on the "Record" toolbar"	7.00	6.25
SWITCH CAMERA	**DAY**	**NIGHT**
18. SWITCH CAMERA: Switching to video view mode and to switch camera, pressing the "Forward / Downward Camera" icon on the "Video" toolbar	5.73	6.50
19. MARKING A TARGET: Switching to video view mode, aligning crosshairs on target, and pressing the "Mark Target" icon on the "Video" toolbar	5.00	3.50
20. SNAPSHOT: Pressing the "Take Snapshot" icon on the "Video" toolbar and pressing the "Save" button	4.78	6.00
21. AIRCRAFT POWER DOWN: Setting Power switch: DOWN, setting Servo switch: DOWN, check Remote Launch switch: DOWN, and check Zeroize switch: DOWN	7.00	6.50
22. GROUND STATION POWER DOWN: Check Zeroize switch: UP and on OCU, selecting "File -> Shutdown"	7.00	6.25
23. AIR VEHICLE DISASSEMBLY: Detaching Upper Black and Lower Red rubber straps from Payload Pod, disconnecting Payload Pod from AV, detaching Upper Black and Lower Red rubber straps from Avionics Pod, disconnecting Avionics Pod from AV, inserting Pods into transport carrier, removing Foot Braces from Starter Base, disconnecting Landing Gear from AV, disconnecting and unlocking Starter Hub from Starter Base, unscrewing Starter Legs from Starter Base, inserting Starter Hub, Legs, and Foot Braces into transport carrier, and inserting AV into transport carrier	7.00	6.25
24. GROUND STATION DISASSEMBLY: Disconnecting OCU from GDT, positioning Radio Antennas: DOWN, and packing for transport	7.00	6.25
25. PACKING FOR TRANSPORT: Opening all containers/packs, stowing Air vehicle, stowing fuel containers, stowing starters, stowing Ground Control Station, stowing Ground Data Terminal, stowing Operator Control Unit, and closing all containers/packs	6.25	6.50
AFTER LANDING	**DAY**	**NIGHT**
26. FIELD CHARGING SYSTEM: Plugging NATO Slave Connector Power Cable #1 to Charger Block, plugging Power Cable from Charger Block to AV battery, plugging Power Cable #2 from Charger Block to GDT power jack, plugging OCU to GDT Power Cable from the GDT power jack to OCU power jack, and plugging NATO Slave Connector to HMMWV Outlet – CONNECTED	NA	NA

Comments	Responses
DAY	
1) Area was suitable; had trouble launching MAV after we had previously tuned it. We moved it 50 meters from where we tuned it and it died.	1
1) Launch okay. Recovery area was hard to find and wasn't as familiar as the launch area.	1
1) Launching I had a signal but as soon as started flying over the crest of the hill I lost it.	1
1) Video did not look good when landing.	1
4) The fueling syringes are starting to be hard to pull and the tubes are collapsing when I pull it.	1
4) Fueling and de-fueling right before mission takes too long we shouldn't have used the MAV for this mission because of this.	1
6) Had problems with video link and ended up going through three OCUs and two GDTs to get it to work.	1
9) MAV tuning is too touchy for us to use. We shouldn't have to re-tune it. It had already been tuned.	1
10) The OCU shut off in middle of flight plan.	1
13) The vehicle would not respond to any commands unless I went to hover then put commands in. I did this frequently.	1
13) Would not respond to commands given and had to redo.	1
14) There was a delay when I wanted to suspend or resume plan.	1
16) AV did not respond to go to command when entered MSL read O when it was about 300 ft.	1
16) When coming in to land, it would not respond to my go to command immediately and eventually came back.	1
17) OCU shut off and video was lost on both OCUs	1

Comments	Responses
18) There was some delay when switching cameras	2
18) I had no video.	1
20) When the wind pushes the MAV around, it is very difficult to get a snapshot of a target.	5
25) The MAV needs to be assembled while being transported for a quicker launch.	2

NIGHT

2) The blue power on light on the OCU is too bright.	2
4) Fueling takes too long and you need to have an extra person holding a light to watch for air in line at night.	2
4) Fueling takes too long especially when attempting a continuous flight mission	2
4) The O Ring in the syringe broke while I was fueling one of the vehicles.	1
5) Using NVGs makes the task of checking slower.	1
8) Easy during daylight, can't really see all four servos moving at same time with NVGs.	1
13) AV needs to move faster during manual control.	1
20) Taking snapshots gets harder as wind picks up.	1
20) Not easy to get crosshairs on target. Need to have movable camera.	1
20) A gimbaled camera would be very helpful in stabilizing the video.	1

2. Please rate the following characteristics of the g-MAV you used during the trial.

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

	MEAN	
	DAY	NIGHT
1. Size of each component.	6.09	5.00
2. Weight of each component.	6.09	5.25
3. Shape of components.	4.36	5.75
4. Storage location of components.	6.40	5.50
5. Access to components when stored.	6.40	5.25
6. Assembly/mating of components.	4.60	5.25
7. Compatibility with clothing and equipment.	4.70	4.75

DAY

Components break easy such as pod connectors. One broke on me and we weren't able to fly the two birds at one time. Push-button starter would be better than a pull start.	1
Components are too fragile; they break easy, pod connectors, starter strap.	5
Equipment gets caught on everything, antennas will break, and the system will break too easy.	1

3. Was there anything about an individual component or task during this trial that made unpacking, placing into operation, or packing more difficult?

	YES	NO
DAY	2	9
NIGHT	0	4

Comments	**Responses**
DAY	
Tuning made it tough. We had it tuned and should have flown because it had been tuned beforehand.	1
We weren't getting video link with OCU and had to switch OCUs and GDTs.	1

4. Was there anything about the g-MAV system during this trial that made it unsafe for you to use or unsafe to others during the trial?

	YES	NO
DAY	1	10
NIGHT	0	4

DAY	
When landing, the g-MAV lost the AGL (above ground level) sensor and didn't kill itself and I had to hit EK (engine kill) to shut it off.	1

AUTONOMOUS/MANUAL FLIGHT MISSIONS

SAMPLE (N) = 6

1. Using the scale below, please rate your ability to perform the following **Autonomous** flight tasks during this mission.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

	MEAN
1. Uploading flight plan to Air Vehicle	5.85
2. Send uploaded flight plan to Air Vehicle	6.10
3. Executing flight plan	6.30

Comments	Responses
First time I used a flight plan so it was also a little bit of a learning experience then just executing the steps for the flight plan, but overall the flight plan was pretty simple after I did it.	1

2.a. Was manual control assumed during this flight?

YES	NO
6	0

b. If yes, using the scale below, please rate your ability to perform the following manual flight tasks during this mission.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

	MEAN
1. Suspending flight plan.	6.21
2. Executing “UP/DOWN” commands	6.29
3. Taking out “UP/DOWN” commands	6.42
4. Executing “LEFT/RIGHT” commands	6.42
5. Taking out “LEFT/RIGHT” commands	6.42
6. Executing “FORWARD/REARWARD” commands	6.38
7. Taking out “FORWARD/REARWARD” commands	6.38
8. Rotating g-MAV “LEFT/RIGHT”	6.38
9. Taking out g-MAV “LEFT/RIGHT” rotation commands	6.38
10. Executing “Hover”	6.39
11. Resuming flight plan.	5.86
12. Executing “Landing”	6.36
13. Overall conducting mission	6.11

Comments	Responses
Awesome experience, high-speed, very easy to control.	1
Didn't use the resume key, but overall the g-MAV performed well.	1
Entire mission done autonomously, very easy to push button and watch.	1
The run was very smooth. I had no run in with any problems with AV, OCU or controls.	1
Mission went well couldn't get good visual on vehicle because of the wind.	1
The AV battery went low and the GDT battery went low.	1
Using manual commands is very easy except for the drift once you take out the command. Once you get used to it and get the timing down it shouldn't be a problem.	1

3. Does the design of the manual control icons accurately reflect the action they are intended to produce?

YES	NO
6	0

4. Please rate the following characteristics of the g-MAV you used during the manual flight trial.

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

	MEAN
1. Responsiveness to flight commands (up, down, left, right, rotate left/right etc.)	6.08
2. Switching between forward-looking and downward-looking camera views	6.09
3. Transitioning between autonomous and manual control and back	6.05
4. Sending g-MAV to a GO TO point or point of interest	6.37
5. Sending g-MAV to a designated map position	6.35

1) Too sluggish at times, not enough speed options in manual mode. Higher winds keep MAV form moving.	1
4and5) On the first day the "go to" worked great and was very easy to use, on the second day, the AV lost altitude every time "go to" was used.	1
The "go to" option is outstanding when switching camera views, the reception got a little fuzzy from going down from forward. And when I was recording, it came in a little broken.	1
All of the functions once you are used to them are awesome. This is my second flight and I felt way more confident and comfortable.	1
I found it easier to get the MAV where I needed it with the "go to" command.	1
The send to designated point was great. I got it there then it started the mission on its own.	1
With the OCV, the internal retention cords got in the way.	1

5. Using the scale below, please rate your ability to perform the following tasks with the OCU.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

	MEAN
1. Changing the display for left or right handed preference	5.30
2. Selecting which image to be viewed in main display area	6.04
3. Selecting which image to be viewed in inset display area	5.93
4. Swapping images from main display area and inset display area	5.70
5. Selecting map or video only	6.04
6. Identifying the location of the g-MAV	6.32
7. Identifying the altitude of the g-MAV	6.21
8. Identifying the heading (direction of g-MAV)	6.11
9. Identifying the location of the GCS	6.21
10. Using the pen stylus with the touch screen	5.04
11. Entering text using the pop-up keyboard	5.83
12. Monitoring battery life	5.46
13. Monitoring flight time	6.36
14. Viewing cautions, warnings, and alerts	6.11

Comments	**Responses**
3) Needs to be on main screen/toolbar	1
4) Double tapping is not working. No. 10 see No. 4, calibration doesn't seem to hold, touching menu to select sometimes takes a few tries	2
4) Had to use drop-down menu, couldn't just double tap.	1
10) Tapping doesn't always work.	1
10) Not very accurate even after calibrating, almost like the screen locks up. 12 should be shown on bottom toolbar with the altitude.	3
12) Important item may need to have displayed at all times.	1
12) Should be displayed on a main toolbar.	1
All these components are very easy. It is good that the OCV has every icon visible or easily obtained great experience.	1
For monitoring flight time you have to make sure the previous flight time from another flight has been erased to get your correct flight time.	1
Sometimes the internal retention cards got in the way of using the stylus in the same position.	2
Stylus needs to realize when it touches. Small delay on the icons coming on and off.	1
Stylus was clicking on things that were nowhere near where I was tapping the screen.	1
The cautions and warning came up a couple of times but the AV took on the mission on its own. Very Impressive.	1

6. Using the scale below, please rate the effectiveness of the following characteristics.

1	2	3	4	5	6	7
Extremely Ineffective	Very Ineffective	Ineffective	Neutral	Effective	Very Effective	Extremely Effective

	MEAN
1. Allocation of screen space (size) for each of the various screens, toolbars, status displays. (Your ability to view the area and gather the information you needed from it)	5.93
2. Size of text and your ability to read the text in each of the various areas	6.14
3. Colors used within each of the various screen sections	6.32
4. Utility or usefulness of each of the various screen areas	6.00
5. Brightness control/adjustment	5.73
6. Contrast control/adjustment	5.73
7. Shapes and symbols used for the various icons	6.14
8. Responsiveness of the display when scrolling	5.68
9. Effectiveness of cautions, warnings and alerts annunciations (visible, audible, vibratory as applicable)	6.11

Comments	Responses
4) Up and down arrows are kind of small and harder to select.	1
8) Sometimes not very accurate or consistent on when trying to select.	1
9) Warnings are annoying when they are not true.	1
Below altitude limit kept popping up randomly and disappeared for a few seconds.	1
The screen glare caused by the sunlight limits the ability to view screen sometimes.	2
In the smaller box the map jumps when scrolling.	1
OCV is the best part about it. I see no flaws other than the stylus.	1
The cautions worked great and allowed me to have a responsive time for me to deal with the problems.	1

7. Did you experience any eyestrain or headache after viewing the display for a period of time?

YES	NO
1	5

I did not like having to hold the black sun screen while trying to operate the OCU. 1

8. Were you able to view the display at a comfortable distance and could you view the display from that distance for long periods of time?

YES	NO
3	3

Comments	Responses
Hangs too low on the IBA.	2
The display has a bad glare if you are not close to it.	3
The two straps that hold the OCU in the case need to have the hooks on both sides so it won't slide off.	1

9. Was there anything about the g-MAV during this event that made it unsafe for you to use or unsafe to others?

YES	NO
2	4

Half of the flight I lost communication link with the bird, causing me to have no control over it.	1
Straps from vest and OCV hanging in front of you while trying to start the AV.	1

10. Taking everything into consideration during this event, what is your overall rating of the g-MAV you just used?

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

MEAN
5.96

Like the AV and controls, hate the vest. May be better if used right on IBA.	1
Being able to switch from auto to manual and back is very easy and useful.	1
Everything went according to plan.	1
I landed on top of a building very successfully	1
Mission was executed with no problems.	1
The vehicle did everything I told it to pretty effectively.	1

MANUAL FLIGHT EXERCISE

SAMPLE SIZE (N) = 6

1. Using the scale below, please rate your ability to perform the following manual flight tasks during this mission.

1	2	3	4	5	6	7
Extremely Hard	Very Hard	Hard	Neutral	Easy	Very Easy	Extremely Easy

	MEAN
1. Executing “Take Off”	6.88
2. Executing “UP/DOWN” commands	6.13
3. Taking out “UP/DOWN” commands	6.25
4. Executing “LEFT/RIGHT” commands	6.13
5. Taking out “LEFT/RIGHT” commands	6.25
6. Executing “FORWARD/REARWARD” commands	6.38
7. Taking out “FORWARD/REARWARD” commands	6.38
8. Rotating g-MAV “LEFT/RIGHT”	6.50
9. Taking out g-MAV “LEFT/RIGHT” rotation commands	6.38
10. Executing “Hover”	6.75
11. Executing “Landing”	6.14
12. Overall conducting mission	6.00

Comments	**Responses**
Executing the Rosetta is fairly easy, but the wind affects the outcome. I feel that if somehow you can manage the wind in a better way, the movement of the AV would be nearly flawless.	1
11) Should have been allowed to land on target or land at way point but wind would not allow land in proper LZ (landing zone).	1
All the manual commands were simple to start and stop but some things (map and video view) needed to be tapped repeatedly.	1
AV crashed.	1

2. Please rate the following characteristics of the g-MAV you used during the manual flight trial.

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

	MEAN
1. Responsiveness to flight commands	5.25
2. Monitoring g-MAV position	6.00
3. Monitoring camera orientation	5.75
4. Monitoring g-MAV elevation	5.38
5. Monitoring g-MAV heading	5.38

Comments	Responses
The wind was a factor in this position too. It is very good at handling itself in heading and elevation, but the wind can shift it little nothing it can't handle thought.	*2*
2and3) The use of map and video along with the green icon showing your view direction was really helpful.	*1*
If using only video you would have no idea what direction you are facing.	1
It took me a little bit to fly in the exact direction I wanted to move. I got better as I was flying.	1

3. Was there anything about employing the g-MAV during this mission that made tasks more difficult?

YES	NO
2	4

The glare on the OCU screen made it very hard to see at moments.	1
The air vehicle cut out while in the air and crashed.	1

4. Was there anything about the g-MAV during this mission that made it unsafe for you to use or unsafe to others during the mission?

YES	NO
1	5

The vest used for training purposes was overly large for some of the shorter guys and was shifting and moving during the start procedure.	1

5. Taking everything into consideration, what is your overall rating of the g-MAV you just used for this mission?

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

MEAN
5.37

The g-MAV was good for me. It did everything I wanted and needed it to. Another nice accessory was the black tarp over the OCV. It made the visual of the video top notch and clear.	1
The first time we attempted to send the bird up, there was no video and the second time it fell out of the sky.	1
The only thing I did not like was the battery wire connection that broke. If you have to change out a whole pod to fix this when it seems to be more work than necessary. The battery wire needs to be changed.	1

Comments	Responses
The only thing I saw a little time consuming and maybe slightly difficult was lining up the crosshairs with the building to get the target location of the building. Waiting for the vehicle to steady itself so the crosshairs lined up is the only thing.	1
Very easy to use and operate with exception of the wind.	1

AFTER-ACTION REVIEWS

Based on the mission or event performed today, please answer the following questions. If a particular question does not apply, mark it as NA.

1. Was the g-MAV system suitable and effective for this type of mission?

MISSION	SAMPLE	YES	NO
Route Reconnaissance	4	3	1
Urban Recon/Search a Building	7	3	4

Comments	Responses
ROUTE RECONNAISSANCE	
The g-MAV gave us a good initial recon picture when we conducted the leader's recon. However, I do not feel the flight time was sufficient to move with the vehicle during the actual recon. It is also hard to maintain stand-off distance on a rate recon	1
Degraded navigation prevented us from accomplishing our mission	1
In a deliberate route recon it can provide constant surveillance from the sky.	1
The g-MAV enabled us to do a leader's recon of the route in which we identified enemy personnel and IEDs. However, on the actual mission the enemy personnel hid under trees, which made identification almost impossible.	1
URBAN RECON/SEARCH A BUILDING	
No-Suitable possibly, effective no. Most targets spotted by conventional means first. g-MAV was able to gain some roof top imagery not available by any other means."	1
Yes-#1 Flight provided good Intel #2 Flight imagery not as good	1
No-Durability and restrictions of use limited our ability to execute our mission effectively	1
No-The MAV was tuned at 1100 hrs in the assembly area; 2 hours later, the MAV needed to be re-tuned 2 hours later because of the 8 degree temperature change. It hindered our mission more than it helped.	1
No-The system took to long to set up I had mechanical issues that took too long to fix for our mission. With more reliability on the system, I believe that we could accomplish our mission.	1
Yes-enabled us to ID targets we could not see with our vehicle LRAS	1
Yes-In a very limited capacity it can be used in conjunction with our other Optics for this mission.	1

2. Could this version of the g-MAV system be improved to better help you in accomplishing the mission you performed today based on the environment, weather, terrain, and light conditions?

MISSION	YES	NO
Route Reconnaissance	4	0
Urban Recon/Search a Building	7	0

Comments	Responses

ROUTE RECONNAISSANCE

See Below-1) Improved durability based on its track record, it will not last in our current operating environment. 2) Integrated video with the Stryker visual display terminal. 3) Omni-directional antenna is needed.	1
See Below-A gimbaled camera is a necessary requirement	1
See Below-Longer flight time and the ability to move faster manually than 6 knots without having to use the "go to" command.	1
See Below-OMNI-DIRECTIONAL ANTENNA!!! with an amplifier mounted on the Stryker	1

URBAN RECON/SEARCH A BUILDING

Self adjusting tuning or fuel injection. 2) The OCU needs to be incorporated into the pre-existing VDT on the Stryker. We do not need another monitor; we cannot functionally operate with a third monitor.	1
Having the system connected to the VDT in the Styles would greatly enhance the PL's ability to maintain SA. System is shaky in high winds; antennas need to be enhanced to increase reception."	1
One camera's picture wasn't as clear as the first camera flight. This could have hindered our ability to ID targets during the mission,	1
A case large enough to carry a fully assembled A/C in or on the Stryker.	1
Durability improvements on Pods	1
Too touchy. We moved 50 meters from where it was tuned and there was a 9-degree F change in temperature and it still needed to be retuned.	1
We need a different fueling method for the MAV. It takes too long with the syringe method and it is hard to see at night to fuel.	1

3. Do any tactics, techniques, and procedures (TTPs) need to be added, changed, or modified in order to effectively employ the g-MAV system for this type mission?

MISSION	YES	NO	NA
Route Reconnaissance	2	0	1
Urban Recon/Search a Building	6	1	1

ROUTE RECONNAISSANCE

Pod exchange and instructions need to be made simpler. It took over 1 hour to effectively launch a bird for the mission after performing a pod switch.	1
Use the system for a leader's recon. Develop a recovery plan.	1

URBAN RECON/SEARCH A BUILDING

1) remove the 100-meter standoff safety requirement 2) remove the "No transporting and refueling" in the vehicle safety requirement."	3
A Stryker PLT is not manned to take out people for MAV Ops in my opinion. (not enough people to dedicate)	1
More practice needs to be done to develop TTPs.	1
See Below-Vehicle has to be tuned hourly. We can't tune then 2 hours later reused.	1

4. Would the introduction of the g-MAV system in your unit adversely affect how you routinely conduct missions?

MISSION	YES	NO
Route Reconnaissance	1	3
Urban Recon/Search a Building	5	2

Comments	**Responses**
ROUTE RECONNAISSANCE	
No-But on some missions we might need more personnel for a recovery team, if we need to land in a location different than our location.	1
Yes See Below-Poor durability, unreliable flight controls and Antenna	1
No-In this mission it would be a great asset.	1
URBAN RECON/SEARCH A BUILDING	
Safety regulations in reference to A/C are hindering our ability to execute our mission. The rules are necessary but they slow us down by not allowing us to transport A/C in the vehicle or refuel, or fly within 100 meters of troops.	1
The durability, sensitivity of tuning and operating create too many limitations for us to tactically employ the g-MAV.	1
Four extra personnel would greatly enhance our ability to employ the MAV at the platoon level.	1
At this point it seems to distract Soldiers and slow down the pace of a planned assault. A dedicated MOS or identifier that could be attached to the PLT could be more effective.	1
It is too unreliable and durability is a major concern.	1
Right now, yes. The g-MAV took me to long to set up. We need two systems per platoon If we have a vehicle go down we can just grab another that has already been prepared.	1

5. What should be the effective operating time and distance of the g-MAV system for this type of mission?

ROUTE RECONNAISSANCE	
60 Minutes 10 KM	3
60 Minutes 5-10 KM	1
URBAN RECON/SEARCH A BUILDING	
30 minutes 5 KM	1
30 minutes 6 KM	1
40 minutes 5-8 KM	1
60 minutes 5 KM	1
90 minutes 10 KM	1

6. What should be the basis of issue (BOI) for the g-MAV system? Please identify the quantity and size organization (e.g., 1/sqd, 2/plt, 3/company, etc.)?

Comments	Responses
ROUTE RECONNAISSANCE	
Two systems per platoon-1 at a minimum with multiple cameras- total 2 IR and 2 ED cameras	1
Two systems per PLT	2
URBAN RECON/SEARCH A BUILDING	
Two complete systems per platoon 4 AC two OCUs	4
Two systems per mounted platoon - 1 per section two fuel cans per platoon.	1
Two systems per platoon or 1 per squad. Plus 4 additional personnel to fly.	1
Two systems per PLT. 1 PLT per company as designated g-MAV PLT	1

7. Based on your answer to question 6, who should be designated to be the primary operator of g-MAV?

ROUTE RECONNAISSANCE	
E1-E4 with NCO supervision	1
E1-E4 in the PSG/PL vehicle	2
E1-E4 w/constant supervision	1
URBAN RECON/SEARCH A BUILDING	
1 operator on the PSG and 1 on the PL vehicle	1
10 level soldiers E1-E4	1
E1-E4 with close NCO supervision	1
Junior enlistees E1-E4 (scout observers)	1
PSG and PL dismounts E1-E4 w/supervision of vehicle commander.	2
Should be an experienced E4 or above	1

8. Would the g-MAV system be effective in helping determine courses of action in a tactical situation?

MISSION	YES	NO
Route Reconnaissance	3	1
Urban Recon/Search a Building	4	3

ROUTE RECONNAISSANCE	
No as a single point of reference it is too unreliable to be counted on	1
Yes-On this type of mission	1
URBAN RECON/SEARCH A BUILDING	
Yes-As long as surprise was not an issue, and it did not slow down the momentum.	1
Yes-It would help determine the number of personnel needed to accomplish the mission.	1
It is not durable to be trusted as a COA Driving force	1

Comments	Responses
No -Restrictions and durability are making the use of this A/C difficult to use. I cannot base decisions off of limited information. Safety regulations are in place due to the durability failures.	1
No -The system is too unreliable and not durable enough.	1

9. Would the g-MAV system be effective in helping develop situational awareness in a tactical situation?

MISSION	YES	NO
Route Reconnaissance	4	0
Urban Recon/Search a Building	7	0

ROUTE RECONNAISSANCE

Yes-incorporated with our other optics it is a force multiplier	2

URBAN RECON/SEARCH A BUILDING

Yes-As of right now my concentration is focused on a small screen but if the video feed were placed on the VDT of the vehicle, the PL and PSG would be able to do multiple task and should be able to monitor the fight. Also it would give other people a chance to see the video from the MAV	1
Yes-For certain areas. Roof tops, as I said in question 1 most targets spotted by LRAS or Binos and OPs	1
Yes-We used it in conjunction with our other optics as a limited force multiplier, i.e., MAV IDs target, LRAS verifies.	1
Yes-Combined with our LRAS it is another force multiplier we can use.	1
Yes-The concept of a PLT level UAV asset is great. This A/C isn't durable enough for us. It is too sensitive to be used in the current operating environment of IRAQ or AFGHANASTAN or any where there are drastic elevation and temperature changes	1
Yes-The g-MAV helps confirm our reports made by our LRAS Gunners which further enhances or SA during the mission.	1

10. Additional comments:

ROUTE RECONNAISSANCE

Having the g-MAV GDT connected to the VDT in the vehicle was very helpful during the Urban Recon and Multiple people were able to see the flight and give an assessment and the picture was much better than the OCU.	1
Poor durability of the pod connectors caused a broken connector and almost caused the pod to go into the servos and Rotor while it was running	1

URBAN RECON/SEARCH A BUILDING

Fueling too touchy. Tuning to touchy. Would most likely have packed it in after first MAV wouldn't start	1
We need two systems per platoon	1

END OF TEST

SAMPLE SIZE (N) = 13

1. Using the scale below, please rate the tasks or characteristics of the g-MAV system based on your total experience during this experiment. Please do not leave any questions unanswered. If a question does not apply to you, circle "NA" in the row.

1	2	3	4	5	6	7
Extremely Bad	Very Bad	Bad	Neutral	Good	Very Good	Extremely Good

TASK OR CHARACTERISTIC	MEAN RESPONSE
1. Unpacking components	6.36
2. Assembling the system	6.17
3. Starting the air vehicle	4.67
4. Operating the OCU	5.08
5. Controlling the air vehicle via the touch screen	5.00
6. Creating/modifying flight plans	5.58
7. De-fueling/fueling operations	4.18
8. Troubleshooting procedures	4.33
9. Backpacking the system	6.00
10. Compatibility with clothing and equipment	5.25
11. Durability of the system	2.64
12. Maintainability of the system	3.17
13. Reliability of the system	2.25
14. System malfunctions resulting in lock-up, power down, etc.	2.83
15. Ability to control and maintain camera orientation during flight	3.58
16. Technical manual	4.85
17. Operating range and time	3.42
18. Battery charging procedures/operations.	4.80
19. Quality of camera images received.	5.25
20. Disassembling the system	6.17
21. Packing the components for transport	5.92
22. Component storage cases	6.00

Comments	Responses
11) Not very durable at all, breaks too easily. 13) Does not work half the time. Too sensitive. 14) Happens more often than not sometimes resulting in a crash. 15) Camera goes out a lot of the time. Not very dependable.	1
11) Tips over--breaks. 12) Needs new fuel system. 13) Never know if it's actually going to lift off when it's needed. 15) Moves too much to get steady picture, partly weather related. 17) Too short--needs more flight time.	1

Comments	Responses
3) Starter is flimsy; it needs to be a push-button starter. 4, 5) Touch screen needs to be incorporated into the FBCB2 for control. 7) Needs to be diesel. High grade gas is a logistical problem fuel syringe seizes up, needs to be incorporated into Stryker	1
3) Starting the vehicle is simple, but electronic start would be better. 5) refuel/de-fuel is too time consuming. The fueling system needs to be electronic for mounted operations. 8) The troubleshooting guide is not sufficient or easily referenced.	1
7) Takes too much time. 11,13) Too touchy. Doesn't want to start or maintain link. 14) OCU needs to power down or ghost image stays locked on screen. 17) Needs longer flight time. 19) Poor picture due to loss of signal or wind effects.	1
Item # 11,12,13) Durability is questionable. It needs to be tougher, able to take tipping over and small rain drops. Reliability has been low during the experiment. Everything from lost video controls to the bird not responding as ordered even when commands	1
MAV needs an electronic start with OCU. Launch screen sometimes locks up and works late; you have to double tap things or triple tap things, defueling fueling takes too long with syringes. If a landing leg were to catch on clothing, it would bend easy come apart	1
The very bottom of pack, against your back needs more padding. MAV needs a controllable camera. A different way to fuel MAV.	1
3) Too many times the starter has been broke. Get a push button or something. Plus with everything on, it's a pain to bend over and start it. 7) Should not have to do every time. Plus the actual flight time needs to be tested. No one knows exactly how long it will fly	1
With flight plans it would be easier with an edit/undo button. Half of the time the birds will not fly. TM should have a troubleshooting section.	1

2. In your opinion, does the g-MAV improve mission effectiveness?

YES	NO	NR
7	4	2

In some cases YES and in others NO. When the MAV actually gets in the air with no problems, the Intel is really good, but when it is not working, we spend too much time troubleshooting, which caused us to lose momentum and violence of action.	1
It could in a very controlled circumstance, when time was not an issue. However, for scouts I don't believe the effort and time equal the payoff.	1
It would on certain missions, not all. Need time to set it and 1 tune etc…	1
The system is unreliable, fragile and cannot be trusted as an asset.	1
When it works, no problems whatsoever; it does help to identify things in Urban Operations. For our other missions, it was not very useful. When it did not work right away, the mission went wrong and took too much time.	1

Comments	Responses
When the MAV is operational it does bring an added and beneficial dimension to the flight. It allows us to recon without putting Soldiers in danger; however, the system is not reliable and by taking operators from the platoon, this decreases the platoon's combat effectiveness	1
No because reliability sometimes it works good but sometimes it does not.	1
During leader's recon the MAV is a good tool but it seems to have problems running the missions with us.	1
Especially great at clearing rooftops in urban areas.	1
It's not reliable enough to be a critical component of the mission because neither of your birds is operational when you have to use other methods.	1
It generally cost us too much time to get it up and running. Takes Soldiers away from several duties because they are staring at the OCU. Too loud.	1
Slows down the mission.	1

3. How could the g-MAV system be improved?

Component durability, flight time increased to 2 hours as 1-1/2 hours fuel sensor, electronic start from OCU during manual command of bird top speed should be increased to double or triple of what it is now.	1
Fly longer, less touchy more durable reliability, too long to fuel.	1
I think a purge valve for the fueling would be outstanding. Do not base missions around the g-MAV. It needs to be a bit more durable. It is too touchy/feely.	1
Make it quieter, tougher; fly longer and more idiot proof. Remember if a Soldier has to think too much, the chances are it won't get used.	1
More durable, longer flight time.	1
Quiet it down. Control of camera, not just control of g-MAV. Stronger signal. More reliable. One touch go to commands. Higher speeds in manual flight.	1
The tuning could be semi auto? Or at least not have to be retuned after a 2-degree change in temperature; the system could also have a fuel pump/injector.	1
Make it more reliable.	1
Make it stronger and more durable; the AGL series needs to be replaced with a more effective sensor. We have lost multiple MAVs due to an improper AGL reading. Electronic starter and fuel would greatly enhance mission.	1

4. Stryker integration comments. (transporting, employing and operating the g-MAV from the Stryker)

Comments	Responses
Batteries need to be integrated to the charger on the move. The antenna is horrible. Something needs to be done with it. Also, everything is a little bulky for the Stryker. Don't know if it can be condensed but we carry enough as it is.	1
It seems to have problems getting video with OCU when hooked up to VDT screen in Stryker, antennas are too flimsy on Stryker for MAV.	1
Most definitely easier to transport via vehicle. It seems like the vehicle compatibility issues could be worked through in time. Being able to view the imagery on the VDT would be a huge improvement.	1
A launch pad on the rear at the Stryker would help immensely.	1
Can take too much time to deploy--diesel engine would save that time easy to transport.	1
If we can effectively launch the MAV on a vehicle and/or on the move, then all the better.	1
The following items need to be incorporated with Stryker. 1) Launch platform from Stryker. 2) OCU incorporated with the FBCB2. 3) Carry case large enough to carry fully assembled A/C. 4) Fuel system (pump) from Stryker. 5) Mounted vehicle antenna and GDT on Stryker	1
Video and controls on VDT. Link to FBCB2 so coordinates can be auto placed on screen. Need to be able to transport inside Stryker.	1
We need a more effective omni-directional antenna to maintain GDT and AV link with the MAV. The antenna needs to reach at least 8 kilometers. We need a new transport method for the MAV	1

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